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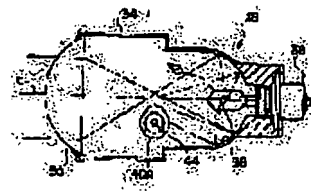
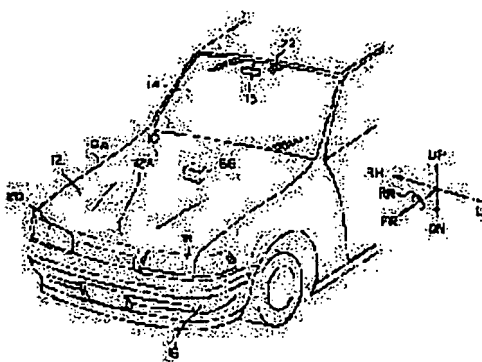
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(54) HEADLIGHT FOR VEHICLE

(57)Abstract:

PURPOSE: To prevent headlights from giving glare to a preceding vehicle by detecting the preceding vehicle by the image signal of the front of a vehicle, and detecting the position, according to the illumination of a head lamp.

CONSTITUTION: A TV camera 22 for picking up the image of the situation before a vehicle is arranged in the vicinity of a room mirror 15. The light of a bulb 32 being reflected and condensed with a reflector 38 is shaded with a shading cum 40A of an actuator, and the light excluding it is projected from a lens 30. The cum 40A is rotated by a motor being driven, according to the signal from a controller. Accompanying this rotation, the position of the boundary where the light of the bulb 32 is divided into a passing light and a shaded light changes up and down. This boundary appears as the cut line as the boundary between light and darkness in the light distribution in front of the vehicle 10. The position of the cut line shifts parallel from the position corresponding to the top to the position corresponding to the bottom by the cum 40A being rotated.



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CLAIMS

[Claim(s)]

[Claim 1] the object for vehicles characterized by providing the following -- a headlight -- equipment . The head lamp which can change either [at least] the direction of radiation or the irradiation range An image pick-up means to picturize the situation ahead of vehicles and to output a picture signal A detection means to detect precedence vehicles based on the picture signal outputted from the aforementioned image pick-up means, and to detect the height position of the boundary of the portion by which the light of the aforementioned head lamp which adjoins the field corresponding to the aforementioned precedence vehicles in a picture along the vehicles vertical direction is irradiated, and the portion which is not irradiated Control means which control either [at least] the direction of radiation of the aforementioned head lamp, or the irradiation range so that the height position of the aforementioned boundary detected by the aforementioned detection means becomes below predetermined height to precedence vehicles

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application] this invention -- the object for vehicles -- a headlight -- the vehicles which control the luminous intensity distribution of the head lamp which starts equipment and irradiates the front of vehicles during a vehicles run especially -- a headlight -- it is related with equipment

[0002]

[Description of the Prior Art] Couple arrangement of the head lamp is carried out at vehicles right-hand side and on the left-hand side of the vehicles front end section, when it is difficult to check a front situation by looking like night, the light is switched on, and the front visibility of a driver is raised. When this head lamp has the common composition which the irradiation range can change only to two stages of a high beam and a low beam and the other cars, such as precedence vehicles and opposite vehicles, exist, a low beam is chosen in many cases so that the unpleasant glare which makes the driver of the other car dazzle may not be given. however -- cases, like the distance between two cars with precedence vehicles is long, for example -- a low beam -- a driver -- irradiation of a head lamp -- continuing and viewing dark space out of range, by the high beam, always irradiating the suitable range of front had the problem of being difficult, like giving a glare to precedence vehicles etc.

[0003] For this reason, the gobo for shading irradiation light is prepared in the interior of a head lamp, without giving a glare to the other car, the aforementioned gobo is moved so that sufficient irradiation range may be acquired, and controlling the position of the boundary (this boundary is hereafter called cutline) of an irradiation field and a non-irradiated field is proposed. moreover, it considers as the technology which controls the position of a cutline so that a glare may not be given to the other car, the situation ahead of vehicles is picturized by the CCD camera etc., precedence vehicles are recognized based on the picture signal outputted from a CCD camera, the distance between two cars with precedence vehicles is detected, and controlling the luminous intensity distribution of a head lamp according to the distance between two cars is proposed (refer to Provisional-Publication-No. 62 No. - 131837 official report)

[0004] Moreover, replacing with detection of the distance between two cars based on a picture signal, detecting the distance between two cars and controlling by the radar like the above is also proposed.

[0005]

[Problem(s) to be Solved by the Invention] however, in the control of a cutline based on the above-mentioned distance between two cars As opposed to a target cutline [gap / the attaching position of a headlight] position the positions of an actual cutline differ or When a relative position with precedence vehicles changes with the inclination of vehicles, the inclination of a road surface, etc., the relation between the distance between two cars and the position of a suitable cutline changes, a glare may be given to precedence vehicles, or the irradiation range may be insufficient and the visibility ahead of vehicles may fall.

[0006] the object for vehicles which can prevent that accomplished this invention in consideration of the above-mentioned fact, and it gives a glare to precedence vehicles -- a headlight -- it is the purpose to

obtain equipment

[0007]

[Means for Solving the Problem] the object for vehicles which starts this invention in order to attain the above-mentioned purpose -- a headlight -- equipment The head lamp which can change either [at least] the direction of radiation or the irradiation range, Precedence vehicles are detected based on the picture signal outputted from an image pck-up means to picturize the situation ahead of vehicles and to output a picture signal, and the aforementioned image pck-up means. A detection means to detect the height position of the boundary of the portion by which the light of the aforementioned head lamp which adjoins the field corresponding to the aforementioned precedence vehicles in a picture along the vehicles vertical direction is irradiated, and the portion which is not irradiated, It has the control means which control either [at least] the direction of radiation of the aforementioned head lamp, or the irradiation range so that the height position of the aforementioned boundary detected by the aforementioned detection means becomes below predetermined height to precedence vehicles.

[0008]

[Function] For example, in a projector type head lamp, the boundary (namely, cutline) of the portion (bright section) by which the light from a head lamp is irradiated, the portion (dark space) by which light is not irradiated, and ** appears comparatively clearly. For this reason, precedence vehicles are detected based on the picture signal showing the situation ahead of the vehicles outputted from the image pck-up means, and it is made to detect the height position of the boundary of the portion by which the light of the head lamp which adjoins the field corresponding to the precedence vehicles in a picture along the vehicles vertical direction is irradiated, and the portion which is not irradiated in this invention.

[0009] Although the bright portion and the dark portion adjoin, for example along the vehicles vertical direction in the field corresponding to the precedence vehicles in a picture also in the edge portion of the tail lamp of precedence vehicles The boundary of the irradiation portion and the non-irradiating portion which are produced by the headlight Usually, by making applicable to detection only the boundary which is continuing more than predetermined length along the vehicles cross direction, for example, is continuing more than predetermined length It is not incorrect-detected, using the edge section of a tail lamp as a cutline, only a cutline can be extracted and the height position can be detected.

[0010] And either [at least] the direction of radiation of a head lamp or the irradiation range is controlled by this invention so that the height position of the detected aforementioned boundary becomes below predetermined height (for example, height of the tail lamp of a precedence vehicle) to precedence vehicles. Thus, since the luminous intensity distribution of a head lamp are controlled based on the height position of the cutline which detected and detected the height position of a cutline itself And a relative position with precedence vehicles changes with the inclination of vehicles, the inclination of a road surface, etc., or [that the distance between two cars changes] [that the attaching position of a head lamp has shifted] It can prevent certainly also in **, giving a glare at precedence vehicles, since the position of the cutline to precedence vehicles can be made below into predetermined height.

[0011]

[Example] Hereafter, with reference to a drawing, the example of this invention is explained in detail. as shown in drawing 1 , the engine hood 12 arranges in the upper surface section of front body 10A of vehicles 10 -- having -- **** -- the front end section of front body 10A -- the vehicles cross direction -- once -- since -- the other end is covered and the front bumper 16 is being fixed The head lamps 18 and 20 of a couple are arranged in vehicles cross direction both ends between this front bumper 16 and the first transition section of the engine hood 12.

[0012] Windshield glass 14 is formed near the back end section of the engine hood 12, and the room mirror 15 is formed in it near the part corresponding to the upper part side of the windshield glass 14 of the vehicles 10 interior. TV camera 22 for picturizing the situation ahead of vehicles near the room mirror 15 is arranged. TV camera 22 is connected to the image processing system 48 (refer to drawing 4). The TV camera which outputs the picture signal which is equipped with the CCD element which detects only the quantity of light as TV camera 22, and expresses monochrome picture with this example is used.

[0013] In addition, as for the arrangement position of TV camera 22, it is desirable to be arranged in the position near [as possible] the view position (the so-called eye point) of a driver so that the passage configuration ahead of vehicles can be recognized correctly and it may agree by visual feeling of a driver. Moreover, the passage configuration corresponding to one lane formed with a configuration, for example, the center line, a curbstone, etc. of an advance way is included in the passage configuration in this example.

[0014] Moreover, the speedometer which is not illustrated is arranged by vehicles 10 and the vehicle speed sensor 66 (refer to drawing 4) which detects the vehicle speed V of vehicles 10 is attached in the cable of this speedometer that is not illustrated. It connects with the image processing system 48, and this vehicle speed sensor 66 outputs the detection result of the vehicle speed V.

[0015] As shown in drawing 2 and drawing 3 , a head lamp 18 is a projector type head lamp, and is equipped with the convex lens 30, the bulb 32, and the lamp house 34. The lamp house 34 is being fixed to the frame which vehicles 10 do not illustrate by the abbreviation horizontal, and a convex lens 30 is fixed to one opening of a lamp house 34, and the bulb 32 is being fixed to opening of another side through the socket 36 so that the point emitting light may be located on the optical axis L of a convex lens 30 (medial axis of a convex lens 30).

[0016] The reflector 38 of an ellipse reflector is formed in the bulb side of the lamp house 34 interior, it is reflected by the reflector 38 and the light injected from the bulb 38 is condensed between a convex lens 30 and a bulb 32. The actuator 40 is arranged in this condensing neighborhood of a point. The actuator 40 equips the axis of rotation 44 fixed so that it might meet crosswise [vehicles] in a lamp house 34 with shading cam 40A supported to revolve possible [rotation], and gearing 40B has fixed to this shading cam 40A. In gearing 40B, gearing 40C which fixed to the driving shaft of motor 40D has geared. Motor 40D is connected to the driver 64 of a control unit 50.

[0017] The light of the bulb 32 by which reflective condensing was carried out by the reflector 38 is shaded by shading cam 40A of an actuator 40, and the other light is injected from a convex lens 30. The distance from the axis of rotation 44 to a periphery is carrying out the cam configuration which changes continuously along with a circumferencial direction, and shading cam 40A rotates, when motor 40D drives according to the signal from a control unit 50. The position of the boundary where the light of a bulb 32 is divided by passage light and the shaded light changes up and down with rotation of this shading cam 40A. It will appear as a cutline (cutline 70 shown in drawing 5) this boundary of whose is a boundary of the light and darkness in the luminous intensity distribution ahead of vehicles 10.

[0018] As shown in drawing 5 , the position of a cutline 70 is moved to parallel from the position (the position shown in drawing 5 as a solid line as a cutline 70, position below the so-called high beam) corresponding to the most significant to the position (the position shown in drawing 5 with a fictitious outline, position of the so-called low beam average) corresponding to the least significant, when shading cam 40A rotates. Moreover, since a head lamp 20 is the same composition as a head lamp 18, although detailed explanation is omitted, the actuator 41 is attached as shown in drawing 4 . The actuator 41 is equipped with shading cam 41A which is not illustrated, and the position of a cutline is moved with rotation of shading cam 41A.

[0019] As shown in drawing 4 , the control unit 50 is constituted including the buses 62 which connect a read-only memory (ROM) 52, RAM (RAM) 54, a central processing unit (CPU) 56, input port 58, an output port 60, and these, such as a data bus and a control bus. In addition, the map and control program which are mentioned later are memorized by this ROM52.

[0020] The vehicle speed sensor 66 and the image processing system 48 are connected to input port 58. This image processing system 48 carries out the image processing of the image picturized by TV camera 22 based on the signal inputted from TV camera 22 and a control unit 50 so that it may mention later. The output port 60 is connected to the actuator 40 of a head lamp 18, and the actuator 41 of a head lamp 20 through the driver 64. Moreover, the output port 60 is connected also to the image processing system 48.

[0021] Next, an operation of this example is explained with reference to the flow chart of drawing 6 and drawing 7 . If a driver turns on the light switch which vehicles 10 do not illustrate and head lamps 18

and 20 are made to turn on, the control main routine shown in drawing 6 for every predetermined period will be performed. At Step 300 of this control main routine, precedence vehicles recognition processing is performed and the precedence vehicles precede with self-vehicles and it is running are recognized. This precedence vehicles recognition processing is explained with reference to the flow chart of drawing 7.

[0022] When vehicles 10 are running the road 122, an example (image 120) of the image which carried out abbreviation coincidence with the picture checked by looking by the driver picturized by TV camera 22 is shown in drawing 8 (A). This road 122 equips with the white line 124 the both sides of the lane vehicles 10 run. In addition, a position is pinpointed by the coordinate (X_n and Y_n) of the system of coordinates which become settled by the X-axis by which each pixel on the above-mentioned image was set up on the image, and which intersects perpendicularly respectively, and the Y-axis. Below, recognition of precedence vehicles is performed based on this image.

[0023] At Step 400, the field which has the predetermined width of face gamma on an image as shown in drawing 9 is set up as a white line detection window field Wsd. In this example, the white line of the position which crosses 60m of front of vehicles 10 in consideration of only the picture to the abbreviation 40-50m ahead of vehicles 10 being undetectable at the time of a night run of vehicles 10 is not detected. Moreover, for the field of the lower part in a picture, the accuracy in which precedence vehicles exist is a low. For this reason, the white line detection window field Wsd which removed the downward field from a 140 or more-horizontal line predetermined field and the predetermined minimum line 130 is set up so that the white line detection window field Wsd can be detected even for 60m even of front of vehicles 10.

[0024] At the following step 402, the inside of the window field Wsd is differentiated about brightness, and the peak point (the maximum point) of this differential value is extracted as an edge point which is a white line candidate point. That is, the inside of the window field Wsd is differentiated [pixel / each / horizontal perpendicularly (the direction of drawing 9 arrow A)] about the brightness from the pixel of the lowest position to the pixel of the best position, and change of a luminosity extracts the peak point of a big differential value as an edge point. The edge point which continues by this like the dashed line 132 shown in the window field Wsd of drawing 9 as an example is extracted.

[0025] Straight-line approximation processing is performed at Step 404. This processing carries out straight-line approximation of the edge point extracted by white line candidate point sampling processing using the Hough (Hough) conversion, and asks for the approximation straight lines 142 and 144 which met the line presumed to be a white line. intersection PN which asked for and asked for the intersection PN of the approximation straight line for which it asked (X coordinate value = X_N) at the following step 405 a horizontal variation rate with the intersection P0 (X coordinate value = X_0) of the approximation straight line in the case of the straight-line way which is made into criteria and which was appointed beforehand -- an amount A ($A = X_N - X_0$) is calculated This amount A of displacement corresponds to the degree of the curve of a passage 122.

[0026] At the following step 406, the amount A of displacement is $A_2 \geq A \geq A_1$. A passage 122 judges whether it is an abbreviation straight-line way by judging whether it is within the limits. This criterion value A1 It is a reference value showing the boundary of a straight-line way and a right curve way, and is the criterion value A2. It is a reference value showing the boundary of a straight-line way and a left curve way. When judged with a straight-line way at Step 406, the vehicle speed V of the self-vehicles 10 is read at Step 408.

[0027] Vehicles recognition field WP which recognizes precedence vehicles at the following step 410 according to the read vehicle speed V Amendment amendment width-of-face α_L and α_R are determined for the position of an approximation straight line in setting up. At the time of a high-speed run, even if the direct front of vehicles is a passage near an abbreviation straight line since the radius of curvature which can circle is small at the time of a low-speed run, although it can consider that it is running the passage of an abbreviation straight line, since the radius of curvature of the passage in which vehicles can circle is large, when the radius of curvature of a passage is small at the distant place, vehicles are the vehicles recognition fields WP. Shell deviation may be carried out. For this reason,

aforementioned amendment width-of-face α_L and α_R Using a map as shown in drawing 12 , it is determined that a value becomes large as speed V becomes low.

[0028] the following step 412 -- the minimum line 130, amendment width-of-face α_L , and α_R Vehicles recognition field WP for carrying out recognition processing of the precedence vehicles for the field surrounded in the approximation straight lines 142 and 144 by which the position was amended

***** -- it determines (refer to drawing 10) In addition, this vehicles recognition field WP

Aforementioned amendment width-of-face α_L according to change of the vehicle speed V and α_R even if it attaches With change, area is enlarged as it becomes a low-speed run (refer to drawing 11).

[0029] if the judgment of Step 406 is denied on the other hand -- Step 414 -- setting -- $A > A_2$ ***** -- by judging, a passage judges a right curve way or a left curve way They are amendment width-of-face α_L according to the vehicle speed V which the passage was judged to be a right curve way, read the vehicle speed V of vehicles 10 at Step 416, and was read using the map shown in drawing 12 when a judgment was affirmed, and α_R . Receiving correction value α_L' and α_R' are determined at Step 418. the variation rate which expresses the degree of a curve with the following step 420 -- an amount A -- responding -- amendment width-of-face α_R of an approximation straight line on either side, and α_L correction value α_R' which determined the gain GL and GR for determining using the map shown in drawing 13 and drawing 14 , and was determined at Step 422, and α_L -- ' and the gain GL and GR -- being based -- final amendment width-of-face α_R of right and left of a window field, and α_L It determines.

[0030] At this time, since a passage is a curve way, it becomes unsymmetrical [right and left], and the approximation straight lines 142 and 144 serve as a different inclination. For this reason, amendment width-of-face α_R on either side and α_L It is set as the independent value. That is, the accuracy to which precedence vehicles exist [a passage] in right-hand side when radius of curvature is small (the amount [Variation rate] A size) is high on a right curve way. Therefore, it is amendment width-of-face α_R by enlarging right-hand side gain GR . It is amendment width-of-face α_L by enlarging (referring to drawing 13) and making left-hand side gain GL small. It is made small (refer to drawing 14). Moreover, when radius of curvature is large (the amount [Variation rate] A smallness) and a passage makes right-hand side gain GR small on a right curve way, it is amendment width-of-face α_R . It is amendment width-of-face α_L by making it small and enlarging left-hand side gain GL . It enlarges. Change of this amendment width of face is shown in drawing 15 as an image.

[0031] amendment width-of-face α_L determined at Step 424, and α_R Vehicles recognition field WP for carrying out recognition processing of the precedence vehicles for the field surrounded in the approximation straight lines 142 and 144 by which the position was amended ***** -- it determines

[0032] On the other hand, when the judgment of Step 414 is affirmed, it judges that a passage is a left curve way, and shifts to Step 426, and the vehicle speed V of vehicles 10 is read. At Step 428, it responds to the vehicle speed V read using the map of drawing 12 , and they are correction value α_R' on either side and α_L' . It determines and the gain GL and GR of the right and left according to the amount A of displacement is determined at Step 430. That is, when radius of curvature is small (the amount [Variation rate] A size) and a passage makes right-hand side gain GR small on the map shown in drawing 16 on a left curve way since the accuracy to which precedence vehicles exist in left-hand side is high, it is amendment width-of-face α_R . It is amendment width-of-face α_L by enlarging left-hand side gain GL on the map which makes small and is shown in drawing 17 . It enlarges.

[0033] Correction value α_R' determined at the following step 432, and α_L' And gain GL , It is based on GR and they are final amendment width-of-face α_R of right and left of a window field, and α_L . It determines. amendment width-of-face α_R of the right and left determined at Step 434, and α_L Vehicles recognition field WP for carrying out recognition processing of the precedence vehicles for the field surrounded in the approximation straight lines 142 and 144 by which the position was amended ***** -- it determines.

[0034] It is the vehicles recognition field WP as mentioned above. If determined, it will shift to Step

436, and it is the vehicles recognition field WP as recognition processing of precedence vehicles. Inner level edge-detection processing is performed. This level edge-detection processing is the vehicles recognition field WP about detecting a level edge point like edge-detection processing of Step 402 first. It carries out inside. Next, peak point EP of a position that integrate with the detected level edge point in a longitudinal direction, and an integration value exceeds a predetermined value It detects (refer to drawing 8 (B)). This level edge has high possibility of appearing when precedence vehicles exist.

[0035] The position coordinate of precedence vehicles is calculated at the following step 438.

Perpendicular edge-detection processing is performed first. peak point EP of the integration value of a level edge point Peak point EP of being caudad located on a picture when there are more than one from - order -- peak point EP The window field WR for detecting a vertical line so that the ends of the level edge point included may be included respectively, and WL It sets up (refer to drawing 8 (C)). This window field WR and WL When the perpendicular edge was detected inside, and vertical lines 138R and 138L are stabilized and are detected, they are the window field WR and WL. It judges with precedence vehicles existing in the field across which it faced.

[0036] Next, the window field WR and WL By asking for the interval of the longitudinal direction of the vertical lines 138R and 138L detected in inner each, it asks for breadth of a car, the coordinate of the center of breadth of a car is searched for as a coordinate of the center of vehicles, and the distance between two cars Len is calculated further. Precedence vehicles recognition processing is ended by the above, and it shifts to Step 302 of the flow chart of drawing 6.

[0037] At Step 302, it judges whether precedence vehicles were detected by above-mentioned precedence vehicles recognition processing. When the judgment of Step 302 is denied, it shifts to Step 306, and according to the distance between two cars Len with precedence vehicles, the angle of the shading cams 40A and 41A is changed, and the position of a cutline 70 is controlled. This control searches for the gain over actuators 40 and 41 using a map as shown in drawing 18 as an example, and is performed by driving actuators 40 and 41 according to this gain. Thereby, the angle of the shading cams 40A and 40B is controlled so that the position of a cutline 70 moves upwards as the distance between two cars Len with precedence vehicles becomes large. In addition, since precedence vehicles do not exist at this time, the angle of a shading cam is unconditionally rotated to the predetermined angle corresponding to a high beam.

[0038] Moreover, when the judgment of Step 302 is affirmed, it shifts to Step 304, and the distance between two cars Len with the precedence vehicles detected by precedence vehicles recognition processing judges whether it is smaller than the predetermined distance A (for example, 100m) defined beforehand. When the judgment of Step 304 is denied, it shifts to Step 306, and position control of the cutline according to the above-mentioned distance between two cars is performed.

[0039] the predetermined field in the picture corresponding to [on the other hand, when the judgment of Step 304 is affirmed, shift to Step 308, and resemble the distance between two cars Len and the perpendicular edge of the precedence vehicles detected by precedence vehicles recognition processing, and it is based, and] the tail section of precedence vehicles -- window field WS ***** -- it sets up This window field WS Perpendicular edge 138L of the couple detected in precedence vehicles recognition processing as shown in drawing 19 (A) as an example, When horizontal line 150A which connects the soffit section of 138R is set up and horizontal line 150B is set as the position which separated only the distance d according to the distance between two cars Len with precedence vehicles from this horizontal line 150A It can consider as the field surrounded with these horizontal lines 150A and 150B and perpendicular edges 138L and 138R. In addition, the value is set to become small as the distance between two cars Len becomes large so that Distance d may not give a glare to precedence vehicles, when the position of a cutline 70 is located up a little rather than horizontal line 150B.

[0040] Window field WS set up above at the following step 310 Image data [inside] is changed into binary data on the basis of a predetermined threshold. When the cutline 70 is located in the position shown in drawing 19 (A) as an example, the portion which the portion by which the light of a head lamp is irradiated, and the portion (portion except the portion shown by hatching from Field WS) corresponding to the tail lamp of precedence vehicles show by the bright section and hatching is judged

to be dark space, and is changed into binary data. At Step 312, it is the window field WS. Inner binary data are differentiated perpendicularly and a differential value detects the value more than constant value. By this differential, it is the window field WS. A differential value turns into a value more than constant value at the point corresponding to the boundary of the bright section and dark space which adjoin along with an inner perpendicular direction, and a point as shown in drawing 19 (B) as an example is detected.

[0041] At Step 314, the differentiating point detected at Step 312 meets horizontally using the Hough (Hough) conversion, carries out straight-line approximation of the point more than constant value, and asks for the approximation straight line presumed to be a cutline. In addition, this straight-line approximation is the window field WS. It carries out from the upper part only to the point corresponding to the boundary which is changing to the bright section from dark space toward a lower part. Thereby, when the point corresponding to the edge section of the tail-lamp bottom of precedence vehicles in a differential value is detected as a point more than constant value, straight-line approximation is not performed to this point. Moreover, the edge section of the aforementioned tail-lamp top is the window field WS. Although it is changing from the upper part to the bright section from dark space toward a lower part, since the edge of this top is not continuing more than predetermined length, it can prevent being incorrect-detected as a cutline by removing a straight line with short length.

[0042] At Step 316, it judges whether it succeeded in straight-line approximation. Height position X_i of the approximation [when the judgment of Step 316 is affirmed, shift to Step 320, and] straight line in a picture It calculates. height position X_i of the approximation straight line detected at Step 322 this time Height position X_{i-n} of the approximation straight line detected n times ago from -- it judges whether it is changing or not The control main routine of this example is performed for every predetermined period, and it moves the position of a cutline each time so that it may mention later. therefore, height position X_i of an approximation straight line Height position X_{i-n} of n times ago from -- when not changing, it is possible to be the straight line in which the detected approximation straight line appeared according to the pattern of the bumper of precedence vehicles etc. In this case, the judgment of Step 322 is denied, it shifts to Step 306, and the cutline position according to the distance between two cars L_{en} with precedence vehicles is controlled.

[0043] On the other hand, when the judgment of Step 322 is affirmed, it can be judged that the detected approximation straight line is a cutline 70. In this case, it shifts to Step 324. In addition, the judgment of Step 322 is affirmed when an approximation straight line is not detected in front of n times. When the judgment of Step 322 is affirmed, the value of the approximation improper counter FC established on memory at Step 324 is set to "0."

[0044] At Step 326, it judges whether the shading cams 40A and 40B were rotated so that the height position of a cutline 70 might move in the fall direction by control of the last cutline. When the judgment of Step 326 is affirmed, it shifts to Step 328, and the shading cams 40A and 40B are rotated so that the position of a cutline 70 may carry out specified quantity movement in the fall direction again. Moreover, when the judgment of Step 326 is denied, it shifts to Step 330, and the shading cams 40A and 40B are rotated so that the position of a cutline 70 may carry out specified quantity movement in the elevation direction. Therefore, by performing Step 328 or Step 330 of this main routine repeatedly, while the cutline 70 is detected, the angle of the shading cams 40A and 40B is controlled so that a cutline 70 moves towards specified quantity [every] regularity.

[0045] Moreover, the position of a cutline 70 is the window field WS by continuing movement in the fixed direction of a cutline 70. Since it becomes impossible to detect a cutline 70 when shell deviation is carried out, the judgment of Step 316 is denied, and it shifts to Step 332. At Step 332, "1" is added to the approximation improper counter FC. Therefore, while the cutline 70 is not detected, as for the approximation improper counter FC, a value will be enlarged gradually. At the following step 334, it judges whether the value of the approximation improper counter FC became larger than the approximation improper threshold value B. When the judgment of Step 334 is denied, it shifts to Step 336, and the value of the approximation improper counter FC judges whether it is more than "2."

[0046] When the cutline 70 detected to last time is no longer detected, the judgment of Step 336 is

denied, and it judges whether the shading cams 40A and 40B were rotated so that the height position of a cutline 70 might move in the fall direction by control of the last cutline. The shading cams 40A and 40B are rotated so that it may shift to Step 340 when the judgment of Step 338 is affirmed, and the move direction of a cutline 70 may be reversed, namely, so that the position of a cutline 70 may carry out specified quantity movement in the elevation direction. Moreover, when the judgment of Step 338 is denied, the shading cams 40A and 40B are rotated so that the move direction of a cutline 70 may be reversed at Step 342, namely, so that the position of a cutline 70 may carry out specified quantity movement in the downward direction.

[0047] Moreover, in case this main routine is performed next, the judgment of Step 336 is affirmed and it shifts to Step 326, and a cutline 70 is moved in the same direction (direction reversed by last time in this case) as the move direction of the last cutline 70 at Step 328 or Step 330. When this continues movement in the fixed direction of a cutline 70 as mentioned above and the position of a cutline 70 deviates from the window field WS, the position of a cutline 70 is Window WS. The angle of the shading cams 40A and 40B will be controlled to return inside.

[0048] Thus, when a cutline 70 is detected again, the judgment of Step 316 is affirmed again, and a cutline 70 is moved in the same direction as last time at Step 328 or Step 330. Therefore, while the cutline 70 is detected normally, the position of a cutline 70 is the window field WS. It controls to move in the fixed direction the specified quantity every in inside, and a cutline 70 is the window field WS. If it passes through inside and a cutline 70 is no longer detected, the move direction of a cutline 70 will be reversed, and it moves in the direction as for which the cutline 70 carried out reversal the specified quantity every, and is the window field WS. It controls to pass through inside

[0049] Thus, window field WS which the cutline 70 set up on the basis of the position of precedence vehicles in this example It is controlling to be located inside and the position of a cutline 70 is the window field WS. When it is judged that it became higher than upper horizontal line 150B, the position of a cutline 70 is reduced. therefore -- that, as for the position of the cutline 70 to precedence vehicles, the attaching position of a head lamp has shifted, or a relative position with precedence vehicles changes with the inclination of vehicles, the inclination of a road surface, etc. **** -- etc. -- it will be controlled to always become a case below predetermined height

[0050] Since a cutline 70 is no longer detected, even if it carries out predetermined time (B approximation improper threshold value) execution of this main routine, when a cutline 70 is undetectable on the other hand, the judgment of the above-mentioned step 334 is affirmed, it shifts to Step 306, and control of the cutline position according to the distance between two cars Len with precedence vehicles is performed.

[0051] In addition, although it had gone detection of the distance between two cars Len with precedence vehicles by this example based on the position of precedence vehicles in a picture, it is not limited to this, the direction where precedence vehicles exist based on the aforementioned picture is detected, and you may make it measure the distance between two cars by ranging meanses, such as a radar.

[0052] Moreover, although this example explained the case where the cutline 70 of the configuration shown in drawing 5 was detected to the example, it is also possible to apply, when detecting the cutline 90 of the configuration toward which the portion corresponding to the left-hand side of an irradiation field receives horizontally, and inclines in the left riser, as this invention is not limited to this and shown in drawing 20 as an example. Moreover, it is also possible to constitute so that the height position of the cutline corresponding to the right-hand side of an irradiation field and the height position of the cutline corresponding to the left-hand side of an irradiation field may be controlled respectively independently.

[0053] Moreover, although the luminous intensity distribution ahead of vehicles were controlled by the shading cam, you may make it shade the light of a head lamp by the gobo or the shutter in the above-mentioned example. Moreover, although luminous intensity distribution are controlled by shading the light of a head lamp, you may make it deflect the injection optical axis of a head lamp.

[0054]

[Effect of the Invention] Precedence vehicles are detected based on the picture signal which picturized the situation ahead of vehicles and was acquired in this invention as explained above. The position of

the boundary of the portion by which the light of the head lamp which adjoins the field corresponding to the precedence vehicles in a picture along the vehicles vertical direction is irradiated, and the portion which is not irradiated is detected. Since either [at least] the direction of radiation of a head lamp or the irradiation range was controlled so that the position of the detected boundary became below the predetermined height that does not give a glare to precedence vehicles The outstanding effect that it can prevent giving a glare to precedence vehicles in various situations at the time of a vehicles run is acquired.

[Translation done.]

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is the perspective diagram which looked at the vehicles in which the vehicles anterior part used for this example is shown from the slanting front.

[Drawing 2] It is the perspective diagram showing the outline composition of the head lamp which can apply this invention.

[Drawing 3] III-III of drawing 2 It is the cross section which met the line.

[Drawing 4] It is the block diagram showing the outline composition of a control unit.

[Drawing 5] It is an image view for explaining the cutline displaced with an actuator.

[Drawing 6] It is a flow chart explaining the control main routine of this example.

[Drawing 7] It is a flow chart explaining the detail of precedence vehicles recognition processing.

[Drawing 8] The conceptual diagram for the image view of a picture where (A) is picturized by the TV camera at daytime, and (B) explaining level edge point integration processing, and (C) are the conceptual diagrams for explaining perpendicular edge-detection processing.

[Drawing 9] It is the diagram showing the window field at the time of white line recognition.

[Drawing 10] It is the diagram showing a vehicles recognition field.

[Drawing 11] It is an image view for explaining fluctuating a vehicles recognition field according to the vehicle speed.

[Drawing 12] It is the diagram showing the relation between the vehicle speed and the amendment width of face of an approximation straight line.

[Drawing 13] It is the diagram showing a relation with the gain which determines the amendment width of face of the approximation straight line of the degree of a right curve way, and right-hand side.

[Drawing 14] It is the diagram showing a relation with the gain which determines the amendment width of face of the approximation straight line of the degree of a right curve way, and left-hand side.

[Drawing 15] It is the image view showing the window field and amendment width of face to a curve way of different curvature.

[Drawing 16] It is the diagram showing a relation with the gain which determines the amendment width of face of the approximation straight line of the degree of a left curve way, and right-hand side.

[Drawing 17] It is the diagram showing a relation with the gain which determines the amendment width of face of the approximation straight line of the degree of a left curve way, and left-hand side.

[Drawing 18] It is the diagram showing a relation with the gain for determining the rotation angle of the shading cam of the distance between two cars and an actuator.

[Drawing 19] (A) is the window field WS set as the tail section of precedence vehicles. The shown image view and (B) are the image views for explaining the process of cutline detection processing.

[Drawing 20] It is the image view showing other examples of the configuration of a cutline.

[Description of Notations]

18 Head Lamp

20 Head Lamp

22 TV Camera

40 Actuator
41 Actuator
48 Image Processing System
50 Control Unit
70 Cutline
90 Cutline
100 Run Vehicles Detection Equipment

[Translation done.]

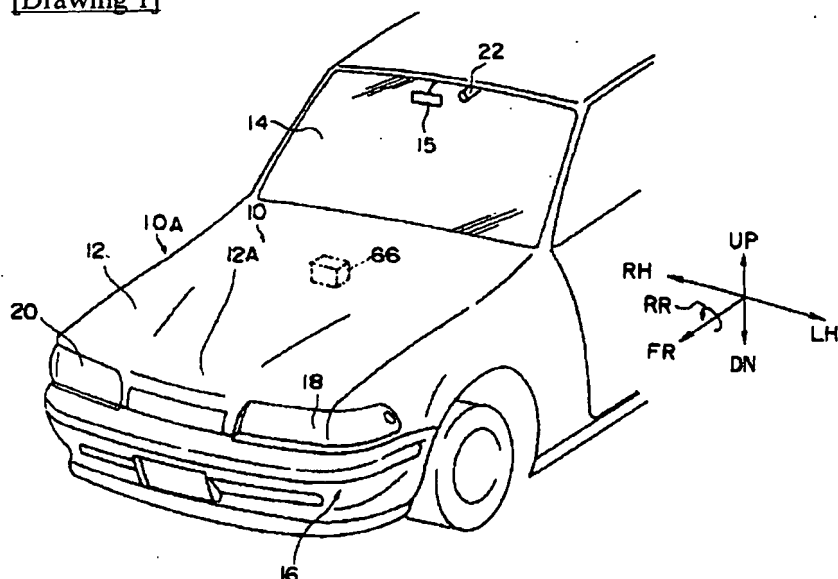
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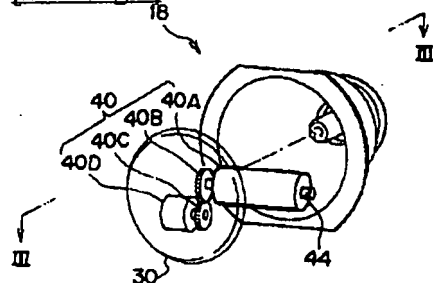
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DRAWINGS

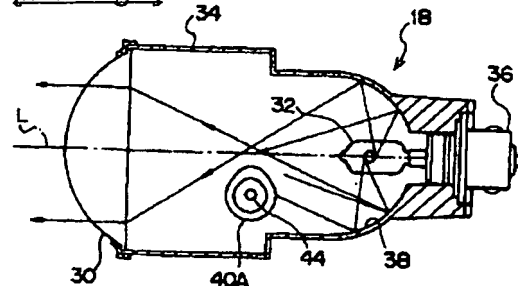
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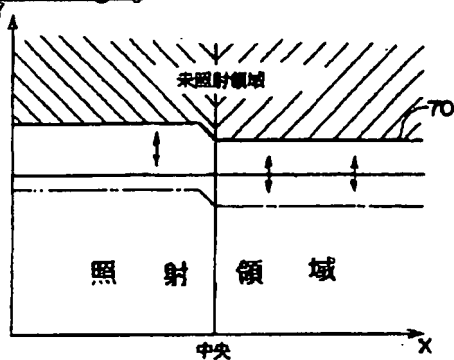
[Drawing 2]



[Drawing 3]

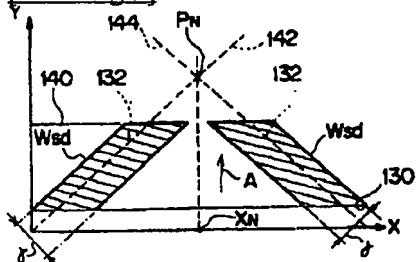


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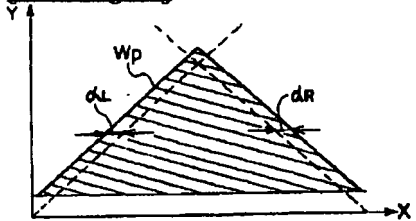


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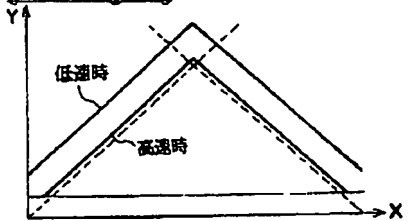
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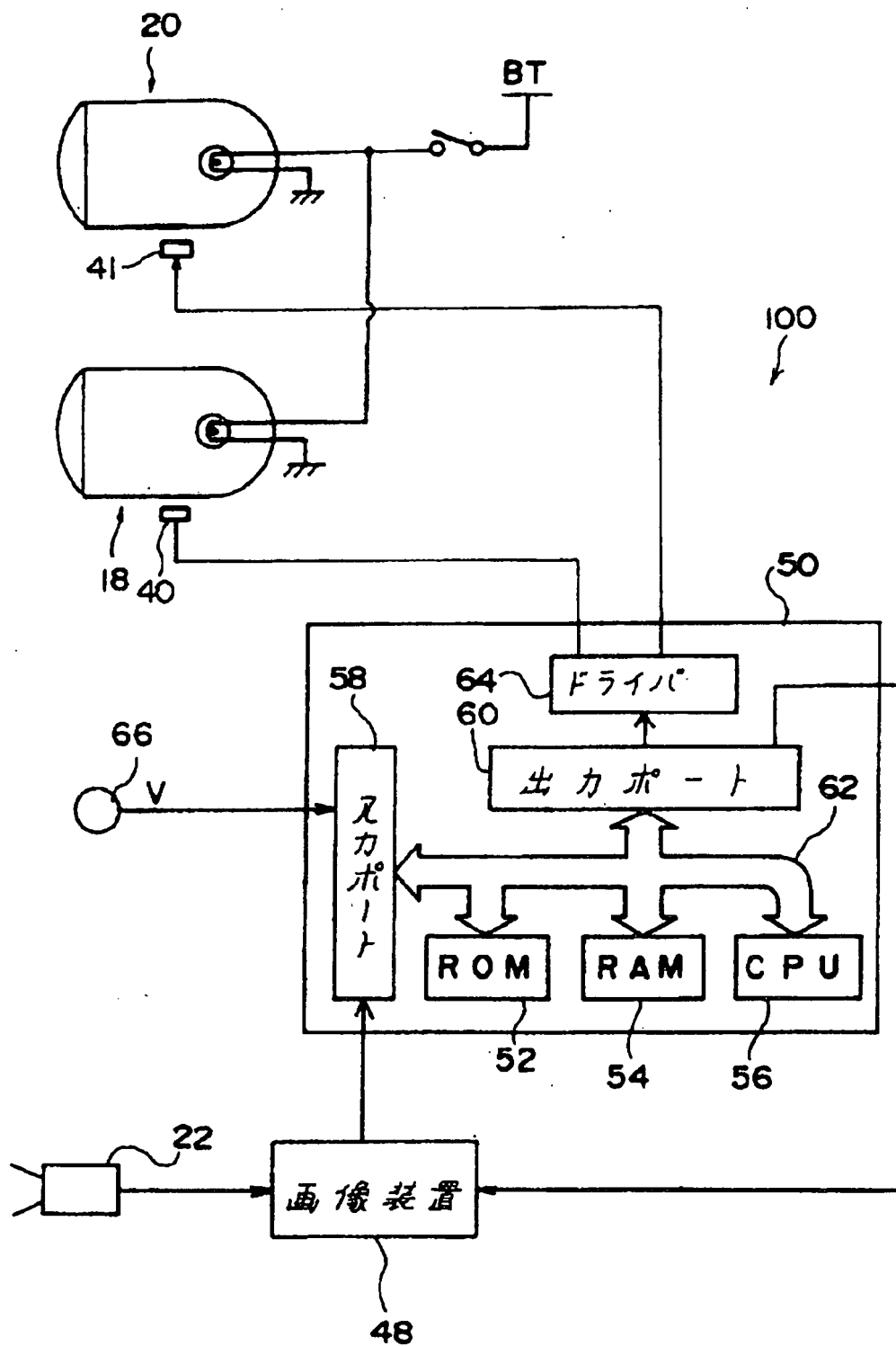
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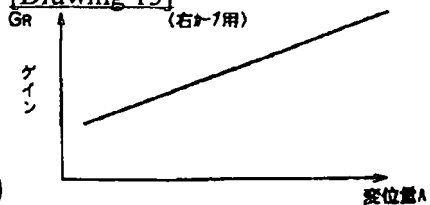
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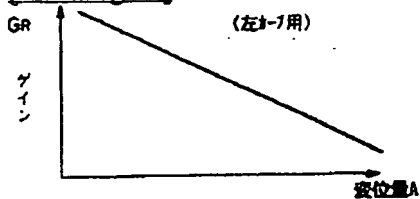
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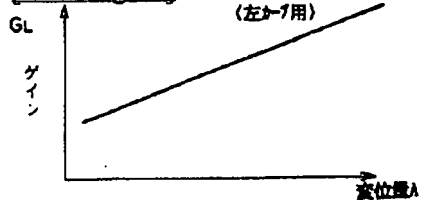
[Drawing 13]



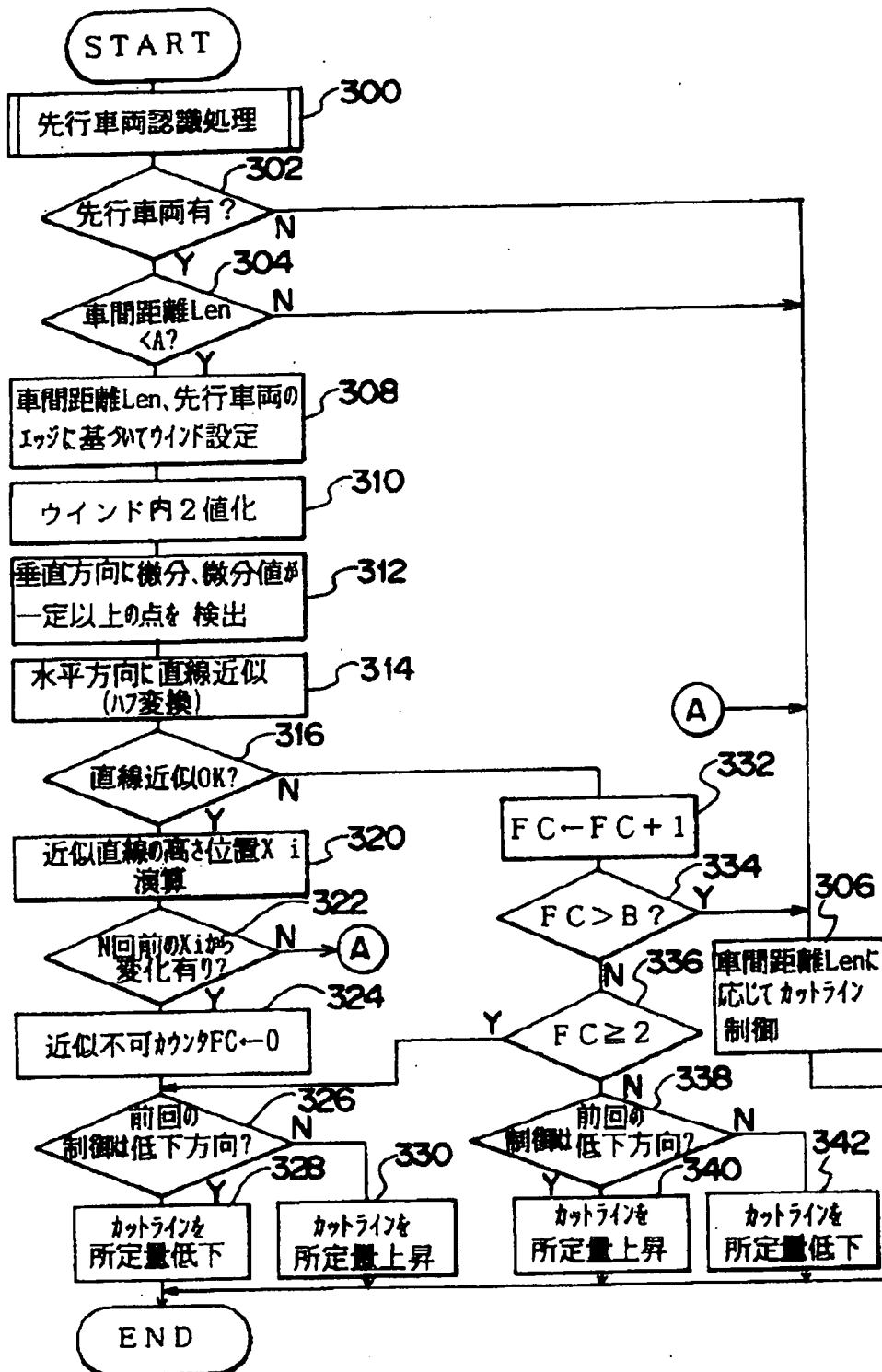
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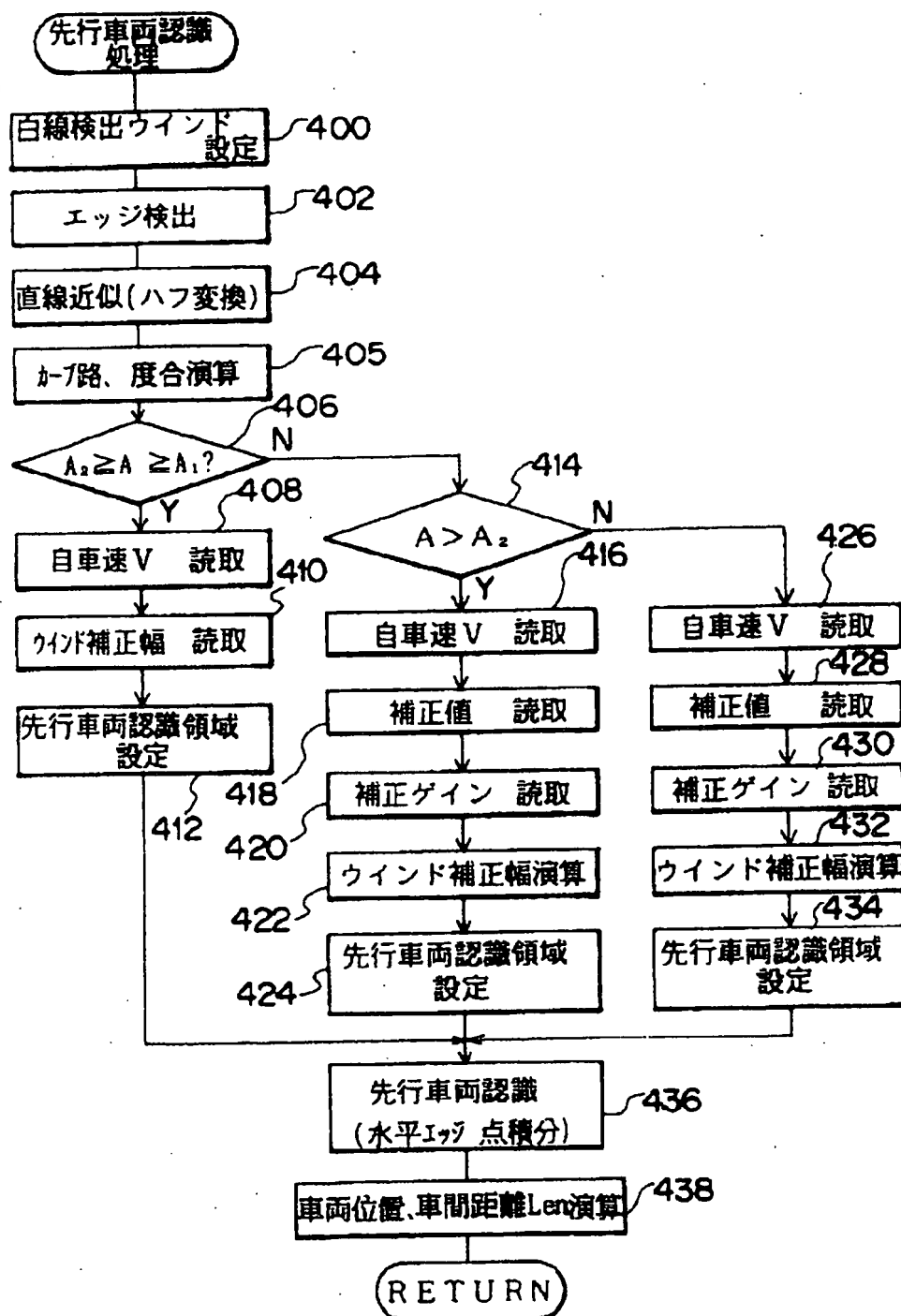
[Drawing 17]



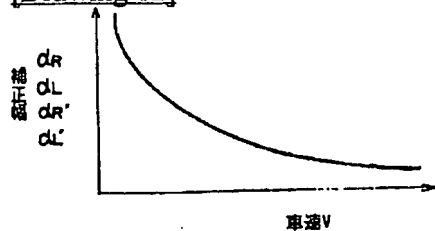
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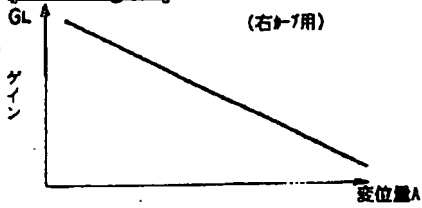
[Drawing 7]



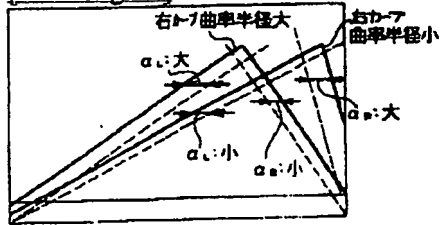
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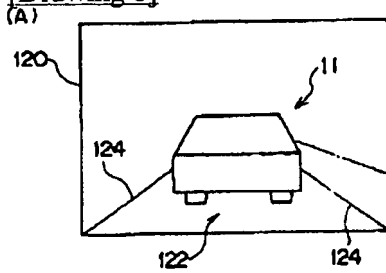
[Drawing 14]



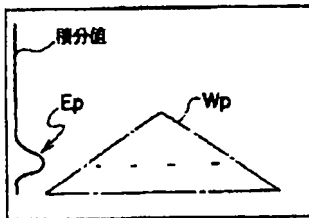
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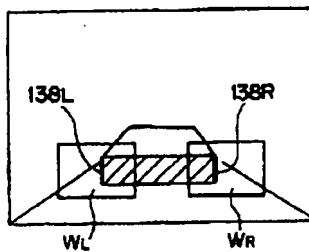
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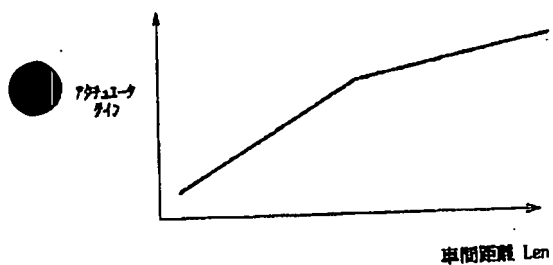
(B)



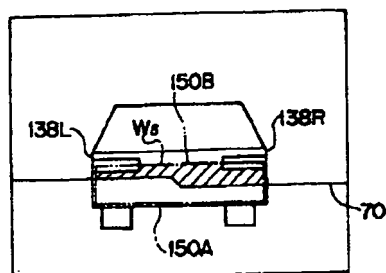
(C)



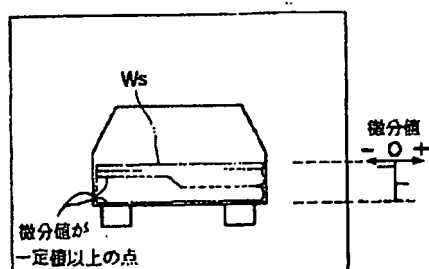
[Drawing 18]



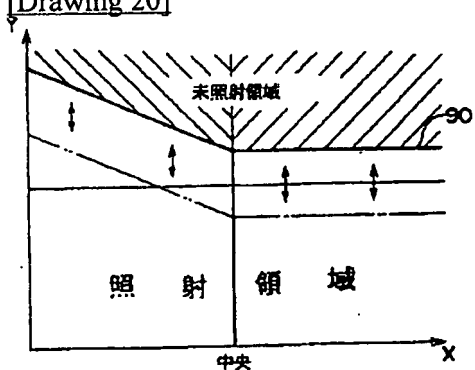
[Drawing 19]
(A)



(B)



[Drawing 20]



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[Translation done.]

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(54) Title of the Invention: HEADLIGHT DEVICE FOR VEHICLES

(57) Summary

(Purpose)

The purpose of the invention is to prevent glare from being inflicted upon a preceding vehicle.

(Construction)

When a preceding vehicle is detected based on an image filmed under the conditions when a vehicle is moving in the forward direction, a window region W_s is set as a standard for the position of the preceding vehicle in the image. Next, after a binary system has been created inside the windows W_s , differentiation is applied in the vertical direction, the point above a

constant value of the differentiated value is detected as the boundary (cut line) between the region which is illuminated by the light from the headlamps and the region which is not illuminated (selected Figure B), and straight line approximation is applied in this point. A cut line 70 is determined as an approximated straight line extended along roughly in the horizontal direction inside the region W_s , so that the position corresponding to the height of the cut line 70 can be moved upward or downward. After that remaining processing has been conducted a specified number of times, if the cut line is no longer detected, while movement is initiated while the direction is reversed, the cut line 70 is controlled with back and forth operations inside the region W_s . Therefore, the height position of the cut line of a preceding vehicle is always below a specified height.

Figure (A)

Figure (b)

[left side] the differentiated value is used to create a constant starting point

[right side] differentiated value - 0 +

[page 2]

Scope of the Patent's Claims

(Claim 1)

Headlight device for vehicles, equipped with headlamps, enabling at a minimum modification of the illumination direction and of the illumination range;

further equipped with a picture taking means, which films the situation in the forward direction of the vehicle and outputs image signal,

with a detection means, which detects a preceding vehicle based on the image signal output from said picture taking means, and outputs the position of the height of the boundary between a part that is illuminated by the light of said headlamps and a part that is not illuminated by the light of said headlamps, adjacent and in the vertical direction of the region corresponding to said preceding vehicle in the image;

and with a control means, enabling at a minimum to control the illumination direction and the illumination range of said headlamps in order to keep the position of the height of said boundary, detected with said detection means below a specified height relative to a preceding vehicle.

(Detailed Explanation of the Invention)

(Sphere of Industrial Use)

(0001) This invention relates to a headlight device for vehicles, in particular to a device controlling the distribution of light of a headlamp providing illumination in the forward direction of a traveling vehicle.

(0002)

(Prior Art Technology) When a pair of headlamps is disposed on the left side and on the right side of the front end part of a vehicle, the light of the headlamps can be turned on to improve the driver's visibility in the forward direction, at night or under similar conditions when visibility is poor. Because such headlamps are generally constructed so that the illumination range can be switched only in two stages, to high beams or to low beams, drivers often choose low beams to prevent glare, as glare can cause an unpleasant blinding sensation of other drivers, when other vehicles, such as preceding cars or oncoming cars, are also present on the road. However, if for example a preceding car is far away, etc., and the driver uses low beams, the result is that the driver will see continuous dark sections in front of the car, and if the driver uses high beams, he may inflict glare upon the driver of a preceding car. Therefore, the problem was that it was difficult to set an optimal illumination range in the forward direction of the vehicle.

(0003) Because of that, it has been proposed to install a light shielding plate inside the headlamp to shield the illumination light to make it possible to obtain a satisfactory illumination range without causing glare for other vehicles by moving said shielding plate, in order to control in this manner the borderline (hereinafter, this borderline will be referred to as cut line) between the illuminated region and the non-illuminated region. Another type of technology that has been proposed to prevent glare from being caused for other vehicles by controlling the position of the cut line is to film the situation in front of the car with a CCD camera or the like, so that the distance from a preceding vehicle can be recognized and detected based on image signal that is output from the CCD camera, and the light distribution of the headlamps is then controlled according to the distance between the vehicles (see Japanese Unexamined Patent Application No. 62-131837).

(0004) It has been also proposed that instead of detecting the distance between the vehicles based on the image signal, said distance between the vehicles can be detected with a radar device, so that control can then be exercised in the same manner.

(0005)

(Problems to Be Solved By This Invention) However, when the cut line is controlled based on the distance between the vehicles as explained above, since the position of the cut line will in reality differ due to factors such as deviations of the position in which the headlight is mounted, if the cut line position is used as a criterion, the relationship between the distance between the vehicles and an optimal position of the cut line will fluctuate also due to factors such as the inclination of the vehicle, or a sloping road surface, which can change the relative position of a preceding vehicle. The result is that glare then will be inflicted upon the driver of a preceding

vehicle, or that the visibility will be reduced in the forward direction of the vehicle if the range of illumination is not sufficient.

(0006) In view of this situation, the purpose of the present invention is to obtain a headlight device for vehicles which makes it possible to prevent glare from being inflicted upon the driver of a preceding vehicle.

(0007)

(Means to Solve Problems) In order to achieve this goal with the headlight device for vehicles according to this invention, the device is equipped with headlamps, wherein at a minimum the direction of illumination and the range of illumination the headlamps can be changed; as well as with a picture taking means, which films the image of the situation in front of the vehicle and outputs an image signal; with a detection means, which detects the height position of the boundary between the part that is illuminated and the part that is not illuminated by the adjacent headlamps, in the vertical direction of the vehicle in a region corresponding to said preceding vehicle in the image, and with a control means, which controls at a minimum the illumination direction and the illumination range of said headlamps in order to lower to a specified height the height of the position of said borderline for a preceding vehicle, which is detected with said detection means.

(0008) If for example a projector type or a similar type of headlamps is used, creating a part which is illuminated by the light emitted from the headlamps (bright part), and a part which is not illuminated by this light (dark part), the border between these parts will appear as a relatively clear border (that is to say a cut line). Therefore, according to this invention, a preceding vehicle is detected based on an image signal displaying the situation in the forward direction of the vehicle, output from a picture taking means, making it possible to detect the height position of the border between the part that is illuminated and the part that is not illuminated by the adjacent headlamps, along the vertical direction in a region corresponding to a preceding vehicle in the image.

(0009) Inside the region which corresponds to a preceding vehicle in the image, a dark part is present adjacent to a bright part, the vertical direction of the vehicle, so that even if this is for example the edge part of the tail lamps of a preceding car, the border between the part that is illuminated and the part that is not illuminated by the headlamp is normally created above a continuous specified length in the width direction of the vehicle. Therefore, when only this border is detected as a subject of detection, for example above a continuous specified length, this makes it possible to detect the height by extracting only the cut line, so that an erroneous detection of a cut line containing the edge part of the tail lamps is prevented.

[page 2]

(0010) Also, according to this invention, the position of the height of said detected border is used to control at least the illumination direction and the range of illumination of the headlamps so that it remains below a specified height on a preceding vehicle (corresponding for

example to the height of the tail lamps of a preceding vehicle). Therefore, since the light distribution is controlled when the position of the height of the cut line is detected based on the detected position of the height of the cut line, even if the distance between the vehicles is changed, or even if the position in which the headlamps are installed fluctuates, and the relative position of a preceding car may also fluctuate due to factors such as the inclination of the car or a sloping road surface, since the position of the cut line can be determined below a specified height in a preceding vehicle, this makes it possible to prevent with reliability glare from being caused for a preceding vehicle.

(0011)

(Embodiment) The following is a detailed explanation of an embodiment of this invention with reference to enclosed figures. As shown in Figure 1, an engine hood 12 is arranged on the front surface part of a front body 10A, and a front bumper 16 is fixed on each end of the front body 10a in the front end part of the front body 10A in the car width direction. A pair of headlamps 18, 20 is mounted on the front edge part between the front bumper 16 and the engine hood 12 in both end parts in the car width direction of the vehicle.

(0012) Windshield glass 14 is installed in the vicinity of the rear end part of the engine hood 12, and a room mirror 15 is installed in the vicinity of the windshield glass 14 on the side above the windshield glass inside a vehicle 10. Near the room mirror 15 is arranged a TV camera 22, which films the situation in the forward direction of the vehicle. The TV camera 22 is connected to an image processing device 48 (see Figure 4). In the present embodiment, the TV camera 22 is a TV camera which is equipped with a CCD element which simply detects only the light amount in order to output an image signal displaying a black and white image.

(0013) In addition, because the position in which the TV camera 22 is arranged should make it possible to recognize with precision the shape of the road in the forward direction of the vehicle, and because the position should also match the visual angle of the driver, it is desirable when the camera is deployed as close as possible to the viewpoint position of the driver (a so called eye point). Further, the shape of the road in this embodiment of the invention includes a continuously progressing road shape, for example a road shape corresponding to 1 car lane formed with a center line and a right edge, etc.

(0014) Further, because a speedometer is also installed in the vehicle 10, in a group of instruments, not shown in the figure, the vehicle velocity V of the vehicle 10 can be detected with a vehicle velocity sensor 66 (see Figure 4) installed in the vehicle. This vehicle velocity sensor 66, which is connected to the image processing device 48, outputs the result of the detection of the vehicle velocity V .

(0015) As shown in Figure 2 and Figure 3, the headlamp 18, which is a projector type of head lamp, is equipped with a convex lens 30, a bulb 32 and with a lamp housing 34. The lamp housing 34, which is fixed roughly in the horizontal direction in a frame, not shown in the figure, of the vehicle 10, is provided on one side with an opening in which the convex lens 30 is fixed, while the light bulb 32 is fixed via a socket 36 in the light emission point of the optical axis L of

the concave lens 30 (central axis of the concave lens 30), in the opening on the other side of the lamp housing.

(0016) Because a reflector 38 is formed by an elliptical reflecting face on the side of the bulb, which is inserted inside the lamp housing 34, the light which is emitted from the bulb 38 and reflected from the reflector 38 is condensed between the light bulb 32 and the convex lens 30. An actuator 40 is disposed in the vicinity of the condensing point of this light. The actuator 40 is equipped with a shielding cam 40A, axially supported to enable rotations of rotary axle 44, which is fixed in the car width direction inside the lamp housing 34, while this shielding cam 40A is fixed to a toothed wheel 40B. This toothed wheel 40B is engaged by a toothed wheel 40C, which is fixed on the driving axle of a motor 40D, and the motor 40 D is connected to a driver 64 of a control device 50.

(0017) The light of the light bulb 3, reflected and condensed by the reflector 38, is shielded by the shielding cam 40A of the actuator 40, while the remaining light is reflected from the convex lens 30. The cam shape of the shielding cam 40A can be continuously changed in the circumferential direction, along the distance from the rotary axle 44 to the outer periphery, while the motor 40D can be driven to induce rotational movements in response to signals obtained from a central control unit 50. Along with the rotation of this shielding cam 40A, the light from the bulb 32 is analyzed and divided in the boundary position, which can be moved upward or downward, into light which is allowed to pass through and into dimmed light. This boundary will appear as a cut line (cut line 70 indicated in Figure 5), representing the boundary between a bright and a dark region with the light distributed in the forward direction of the vehicle 10.

(0018) As shown in Figure 5, the position of the cut line 70 is the position corresponding to the uppermost position of the shielding cam 40A when the shielding cam is rotated (the position indicated by the full line shown with the cut line 70 in Figure 5, which is the so called high beam position), so that the a parallel movement of the cut line position is enabled from this position to a position corresponding to the lowermost position (the position indicated with an imaginary line in Figure 5, corresponding to the so called low beam position). Also, because the headlamp 20 has the same construction as the headlamp 18, a detailed description of this headlamp, on which an actuator 41 is installed as shown in Figure 4, will be omitted. The actuator 41 is equipped with a shielding cam 41A, not shown in the figure, so that the cut line position can be moved along with the rotation of the shielding cam 41A.

(0019) As shown in Figure 4, the construction of the control device 50 comprises a read only memory (ROM) 52, random access memory (RAM 54), central processing unit (CPU) 56, input port 58, output port 60 and a data bus as well as a controller bus,, etc., connected to these components. Also, a map and control program, which will be explained later, is stored in this ROM 52.

(0020) A vehicle velocity sensor 66 and an image processing device 48 are also connected to the input port 58. This image processing device 48 performs image processing operations applied to images filmed with the TV camera 22 based on signals which are input from the TV camera 22

and from the control device 50 as will be explained later. The output port 60 is connected via the driver 64 to the actuator 40 of the headlamp 18, and to the actuator 41 of the headlamp 20.

[page 4]

In addition, the actuator 60 is also connected to the image control device 48.

(0021) The following is an explanation of the operation of the present embodiment with reference to Figure 6 and Figure 7. When the driver of this vehicle 10 turns on a light switch, not shown in the figure, the head lamps 18, 20 are lit up, and the control routine indicated in Figure 6 will be realized in each specified time interval. During step 300 of this control routine, when preceding vehicle recognition processing is conducted and a preceding car is recognized as a car traveling so that it is in front of the car in question, a preceding car is recognized. The reference provided in the flowchart in Figure 7 explains the recognition processing during the recognition of a preceding car.

(0022) As shown in Figure 8 (A), the figure indicates one example of the situation when the vehicle 10, which is traveling on a road 122, films the image of the road with a TV camera 22, wherein the image which is visually perceived by the driver is roughly coincident with the image of this example (image 120). This road 122 is provided with a white line 124 on both sides of the car lane in which the car 10 is traveling. In addition, each image element in said image is specified by its position determined by a coordinate X_D , Y_D , in a system of coordinates determined by intersecting axes, axis X and axis Y, set up in the image. The following recognition operations are performed during the recognition of a preceding vehicle based on this image.

(0023) During step 400, a region having a specified width γ in the image is set as white line detection widow region W_{sd} as shown in Figure 9. In this embodiment, it is assumed that only an image corresponding to some 40 ~ 50 m can be detected in the forward direction of a vehicle 10 as the vehicle 10 is traveling at night. In addition, the probability that a preceding vehicle will be present in the region in the lower part of the image is low. Because of that, when the width line detection window region W_{sd} is set to enable detection up to 60 m in the forward direction of the vehicle 10, the white line detection window region W_{sd} is set so that the region below the lower limit line 130 and above the upper limit of a specified horizontal line 140 is excluded.

(0024) Next, during the step 402, the bright region inside the window region W_{sd} is differentiated and the peak point of this differential value (maximum point) is extracted as the edge point, representing a white line candidate point. In other words, the brightness of each element in a horizontal line is differentiated from the image elements in the lowermost position to the image element in the uppermost position in the vertical direction inside the window region W_{sd} (direction of the arrow A in Figure 9), and the peak point of the large differential value is extracted as the edge point of brightness fluctuations. Therefore, continuous edge points can be

extracted so that detection inside the white detection line window W_{sd} is possible as indicated by the broken line 132 shown in the example in Figure 9.

(0025) Direct line approximation processing operations are conducted in step 404. During this processing, straight line approximation is performed by applying Hough transform to the edge points extracted during the white line candidate point extraction processing, and approximately straight lines 142, 144 are determined along the white line and an estimated line. Next, in step 405, the intersection point P_N of the determined approximately straight line is determined (X coordinate value = X_N) and using this determined intersection point P_N as a standard, the displacement amount A ($A = X_N - X_O$) is determined in the horizontal direction of the intersection point P_O (X coordinate value = X_O) of a straight line determined in advance. This displacement amount A corresponds to the extent of the curve of the road 122.

(0026) Next, during step 406, it is determined whether the road 122 is roughly a straight road by determining whether the displacement amount A is or is not within the range of $A_2 \geq A \geq A_1$. This determined standard value A_1 is a standard value displaying the boundary between a road in a straight line and a road having a right curve, while the standard value A_2 is a standard value displaying the boundary between a road in a straight line and a road having a left curve. When it has been determined that the road is a straight line road in step 406, the vehicle velocity V of the car 10 itself is read in step 408.

(0027) Next, during step 410, when a preceding vehicle is recognized according to the read vehicle velocity V and the vehicle recognition region W_p is set, the position of an approximately straight line is corrected by setting correction amounts α_L, α_R . Because turns can be made only on roads enabling a large curvature radius during travel at a high speed, the travel road is considered to run roughly in a straight line. However, since a small curvature radius enables turning during traveling at a low speed, even if the road immediately in front of the vehicle runs almost in a straight line, there is a possibility that the vehicle may deviate from the car recognition region W_p if the curvature radius of the road in the distance is small. Because of that, a larger value is determined in accordance with a lower vehicle velocity V while using said correction widths α_L, α_R as a map as shown in Figure 12.

(0028) Next, in step 412, the region which is surrounded by approximately straight lines 142, 144, corrected in the position of the lower limit line 130 with the correction widths α_L, α_R , is set as the car recognition region W_p to perform recognition processing for recognition of a preceding vehicle (see Figure 10). In addition, a larger surface area is set according to a lower traveling speed along with the changes of said correction widths α_L, α_R corresponding to the changes of the vehicle velocity V also for this car recognition region W_p (see Figure 11).

(0029) On the other hand, if the determination obtained in step 406 is a negative determination, it will be determined in step 414 whether the statement $A > A_2$ is true, and based on this determination, it will be determined whether the road is a road which has a right curve, or a road which has a left curve. If a positive determination is made in this case, namely, it is determined that the road has a right curve, the vehicle velocity V of the vehicle 10 is read in step 416, and using the map shown in Figure 12, correction widths α_L, α_R are set in step 418 for the left and

right correction widths α_L , α_R . Next, in step 420, in order to determine the correction widths α_L , α_R for an approximately straight line on the left and on the right according to the displacement amount A displaying the extent of the curve, the gains GL, GR are set using the maps shown in Figure 13 and Figure 14. In step 422, the correction widths α_L , α_R are set for the final window region based on the gains GL, GR, and on the determined correction values α_L , α_R .

(0030) Because at this point, the road is a curved road, asymmetry is created between the left and right side, resulting in a different inclination for the approximately straight lines 142, 144. Because of that, the values for the left and right correction widths α_L , α_R are set independently. In other words, when the road is a road which has a right curve and a small radius of curvature (a large displacement amount A), there is a high probability that a preceding vehicle will be present on the right side.

[page 5]

Accordingly, a larger correction width α_R is created by setting a larger gain GR on the right side (see Figure 13). In addition, if the road is a road with a right curve and a large radius of curvature (a small displacement amount A), the correction width α_R is decreased by reducing the gain GR on the right side, and the correction width α_L is increased by increasing the gain GL on the left side. Figure 15 shows an image indicating these correction width changes.

(0031) In step 424, the region surrounded by the approximately straight lines 142, 144 in the position determined with the correction widths α_L , α_R is set as a car recognition region W_p to perform recognition processing for recognition of a preceding vehicle.

(0032) On the other hand, if the determination in step 414 was a positive determination, it will be determined that the road has a right curve, the operation will proceed with step 426, and the vehicle velocity of the vehicle 10 will be read. In step 428, the correction values α_L , α_R are set for the left and for the right side according to the read vehicle velocity V by using the map shown in Figure 12, and the gains GL, GR on the left and on the right are set according to the displacement amount A in step 430. Specifically, because there is a high probability that a preceding vehicle will be present on the left side when the road has a left curve with a small radius of curvature (large displacement amount A), the correction width α_R is decreased by reducing the gain GR on the right side with the map shown in Figure 16. In addition, the correction width α_L is increased by increasing the gain GL on the left side with the map shown in Figure 17.

(0033) Next, during step 432, the correction widths α_R , α_L on the left and on the right of the final region are set based on the determined correction values α_R , α_L and based on gains GL, GR. In step 434, the position of the region surrounded by the approximately straight lines 142, 144, corrected with the determined correction widths α_R , α_L on the left and on the right, is set as a vehicle recognition region W_p to perform recognition processing for recognition of a preceding vehicle.

(0034) When the preceding vehicle recognition region W_p has been set as explained above, the operation proceeds with step 436, recognition processing is conducted for recognition of a preceding vehicle and horizontal edge detection processing is conducted inside the vehicle recognition region W_p . During this horizontal edge detection processing, edge detection is first conducted in the same manner as in step 402, and the detection processing operation is performed inside the vehicle recognition region W_p by detecting the horizontal edge point. Next, the detected horizontal edge points are integrated in the lengthwise direction, a peak point E_p is detected if the integrated value is exceeded (see Figure 8 (B)). There is a high probability that a preceding vehicle will appear in this horizontal edge.

(0035) Next, the coordinate position of a preceding vehicle is calculated during step 438. First, horizontal edge detection processing is conducted. If there are multiple peak points E_p of the integrated value of the horizontal edge point, window regions W_R , W_L are set up for detection of the vertical line so as to include both ends of the horizontal edge point containing the peak points E_p from the side of the peak point E_p in the lower position of the image (see Figure 8 (C)). When a vertical edge is detected inside these windows W_R , W_L , it is determined that a preceding vehicle is present in the region surrounded by the windows W_R , W_L when stabilized vertical lines 138R, 138L have been detected.

(0036) Next, the car width is determined by determining the interval in the horizontal direction of each of the vertical lines 138R, 138L detected inside the windows W_R , W_L , the coordinate of the center of the car width is determined as the central coordinate of the vehicle, and the distance Len from the vehicle is calculated. When the preceding vehicle recognition processing operations described above are completed, the operation proceeds with step 302 explained in the flowchart shown in Figure 6.

(0037) During step 302, it is determined whether a preceding vehicle has or has not been determined by the preceding vehicle recognition processing described above. If the decision reached during the step 302 is a negative decision, the operation is shifted to step 306, the angle of the shielding cams 40A, 41A is changed according to the vehicle distance Len from a preceding vehicle and the position of the cut line 70 is controlled. During this control, the gain for actuators 40, 41 is determined by using the map shown in the example indicated in Figure 18, and the actuators 40, 41 are operated according to this gain. Because the vehicle distance Len from a preceding vehicle is thus increased in this manner, the angle of the shielding cams 40A, 40B is controlled in order to move the position of the cut line 70 in the upward direction. In addition, since no preceding vehicle is present at this time, the angle of shielding cam is changed so that the shielding cam is rotated to the angle set for high beams under the conditions when no preceding vehicle is present.

(0038) Also, if the determination reached in step 302 is a positive determination, the operation is shifted to step 304 and it is determined whether the vehicle distance Len from a preceding vehicle, determined with the preceding vehicle recognition processing, is or is not smaller than a specified distance A determined ahead of time (for example 100 m). If the determination reached in step 304 is a negative determination, the operations proceeds with step 306, and the cut line is controlled according to the distance of the vehicle as described above.

(0039) On the other hand, if the determination made during step 304 is a positive determination, the operation is shifted to step 308 and the window region W_s is set as a region specified inside the image corresponding to the tail part of a preceding vehicle, based on the vertical edge of a preceding car determined during the preceding vehicle recognition processing, and based on the vehicle distance Len . This window region W_s is set by setting a horizontal line 150A connecting the lower end parts of the pair of vertical edges 138L, 138R, detected during the preceding vehicle recognition processing as shown in the example indicated in Figure 19 (A), so that when a horizontal line 150B has been set in a position corresponding only to the distance d according to the vehicle distance Len of a preceding vehicle from this horizontal line 150A, this makes it possible to set a region surrounded by the vertical edges 138L, 138R and by these horizontal lines 150A, 150B. In addition the distance d is set with a smaller value in accordance with a larger value of the vehicle distance Len to avoid glare from being inflicted upon a preceding vehicle even if the cut line 70 is positioned only slightly above the horizontal line 150B.

(0040) Next, during step 310, image data corresponding to the area inside the window region W_s is set, and the data is converted to binary data based on a specified threshold value. In the example indicated in Figure 19 (A), when the cut line 70 is positioned as shown in the figure, the light emitted from the headlamps will be determined as an illuminated part, forming a bright part together with a part corresponding to the tail lamps of a preceding vehicle (in area of the region W_s excluding the part indicated by the hatching line), while the part indicated by hatching line will be determined as a dark part, and the data is converted to binary data.

[page 6]

In step 312, the binary data inside the window region W_s is differentiated in the vertical direction so that a constant value above the differentiated value is detected. During this differentiation, a constant value is created above the value differentiated with the points corresponding to the border between the dark part and the bright part adjacent in the vertical direction inside the window region W_s to detect these points as shown in the example shown in Figure 19 (B).

(0041) In step 314, straight line approximation is carried out in the horizontal direction by applying Hough transform to the points below a constant value of the differentiated points detected in step 312 and an approximately straight line is determined as an estimated cut line. In addition, this straight line approximation is applied only to points corresponding to the border in which the dark part changes into a bright part from the upper part to the lower part of the window region W_s . Because of that, even when points corresponding to the edge part are detected on the lower side of the tail lamp of a preceding vehicle as points above a specified differentiated value, straight line approximation will not be applied to these points. Also, because the edge part on the upper side of said tail lamp changes from a dark part to a bright part in the window W_s , because this edge in the upper part continues beyond a specified length,

erroneous detection of the cut line can be avoided by excluding straight lines which have a short length.

(0042) In step 316, it is determined whether the straight line approximation was successful or not. If the determination in step 316 is a positive determination, the operation proceeds with step 320 and the height position X_i of the approximately straight line in the image is calculated. In step 322, it is detected whether the height position X_i of the approximately straight line detected up to this point is or is not different from the height position X_{i-n} of the approximately straight line detected n times prior to this point. In the present embodiment, once the main control routine has been realized for each specified cycle, the cut line position can be moved as described below. Accordingly, when the height X_i of the approximately straight line has not been changed from the height position X_{i-n} obtained previously n -times, the detected approximately straight line is considered to appear as a bumper pattern or the like of a preceding vehicle. If in this case the determination during step 322 is a negative determination, the operation is switched to step 306 and the cut line is controlled according to the vehicle distance L_n from a preceding vehicle.

(0043) On the other hand, if the determination in step 322 is a positive determination, it can thus be determined that the detected approximately straight line is the cut line 70. In this case, the operation will proceed with step 324. In addition, the determination in step 322 is a positive determination even if an approximately straight line has not been detected previously n times. If the determination during step 322 is a positive determination, the value of an approximation impossible counter FC, which is created in the memory, is set to "0" in step 324.

(0044) In step 326, it is determined whether the shielding cams 40A, 40B have been moved in order to move in the downward direction the height position of the cut line 70 with the cut line control performed previously. If the determination in step 326 is a positive determination, the operation proceeds with step 328 and the shielding cams 40A, 40B are moved by a specified amount in the downward direction to move again the position of the cut line 70. Also, if the determination in step 326 is a positive determination, the operation will proceed with step 330 and the position of the cut line 70 is moved with the shielding cams 40A, 40B with a specified movement amount in the upward direction. Accordingly, when the operations of the present routine are repeated in step 328 or in step 330 during the time period when the cut line 70 has been detected, the angle of the shielding cams 40A, 40B is controlled so as to move the cut line by a specified amount, each time only slightly and in a constant direction.

(0045) Also, since recognition of the cut line 70 may become impossible if the cut line deviates from the cut line position 70 when the cut line 70 is continuously moved from the windows W_s in a constant direction, when the decision made in step 316 is a positive decision, the operation is shifted to step 332. In step 332, "1" is added to the approximation impossible counter FC. Accordingly, the value of the approximation impossible counter will be gradually increased during the time period when the cut line 70 cannot be recognized. Next, during step 334, it will be determined whether the value of the approximation impossible counter FC is or is not greater than the approximation impossible limiting value B. If the determination during the step 334 is a

positive determination, the operation proceeds with step 336 and it will be determined whether the value of the approximation impossible counter FC is or is not greater than "2".

(0046) If the determination in step 336 is a positive determination that the cut line 70 has not been detected up until the previous step, a determination is made whether the shielding cams 40A, 40B have been rotated so as to move in the downward direction the position of the height of the cut line 70 with the cut line control during the previous step. If the determination in step 338 is a positive determination, the operation proceeds with step 340, and the shielding cams 40A, 40B are rotated in order to reverse the movement direction of the cut line 70, that is to say in order to achieve a specified movement amount in the upward direction of the position of the cut line 70. In addition, even if the determination made in step 338 is a negative determination, the shielding cams 40A, 40B are rotated to achieve a specified movement amount in the downward direction of the position of the cut line 70, that is to say by reversing the movement position of the cut line 70 in step 342.

(0047) Also, when the present routine is realized next and the determination in step 336 is a positive determination, the operation proceeds with step 326, and the cut line 70 is moved in the same direction as the movement direction of the cut line 70 in the previous step, namely in step 328 or in step 330 (in this case, the direction was reversed in the previous step). Because of that, if the position of the cut line 70 deviates from the window region W_s while the cut line 70 is being continuously moved in a constant direction, the angle of the shielding cams 40A, 40B is controlled so as to return the position of the cut line 70 inside the window region W_s .

(0048) Therefore, if the cut line 70 has been detected again, and the determination in step 316 is again a positive determination, the cut line 70 will be rotated again in the same direction in step 328 or in step 330.

[page 7]

Accordingly, during the time period when the position of the cut line 70 has been correctly detected, the position of the cut line 70 is controlled so as to achieve constant movement amounts in a constant direction inside the window W_s . If it is no longer possible to detect that the cut line 70 is passing through the inner part of the window region W_s , the direction of the movement of the cut line 70 is reversed and the cut line 70 is controlled with constant movement amounts to ensure that it will pass through the inner part of the window region W_s .

(0049) Therefore, because the cut line 70 is controlled to position it inside the window region W_s , which is set as a standard for the position of a preceding vehicle, the position of the cut line 70 is moved in the downward direction if it has been determined that the position of the cut line 70 is higher than the horizontal line 150 B on the upper side of the window region W_s . Accordingly, even if there are deviations of the position of the cut line 70 which is applied to a preceding vehicle due to the headlamp installation position, control is exercised so that the

position is always maintained at a constant height, even when the relative position of a preceding vehicle fluctuates due to factors such as the inclination of the car, or a sloping road, etc.

(0050) On the other hand, if the cut line 70 can no longer be detected even after the present routine has been run a specified number of time (the number of times corresponding to the approximation impossible limiting value B), in cases when detection of the cut line 70 is not possible, a positive determination is made in step 334 as described above, the operation proceeds with step 306, and the position of the cut line is controlled according to the vehicle distance Len from a preceding vehicle.

(0051) Also, although the vehicle distance Len from a preceding vehicle was detected in the present embodiment based on the position of a preceding vehicle inside the image, the invention is not limited by this, as it is also possible to detect the direction in which a preceding vehicle is present based on said image, and the distance between the vehicle can be measured with a measuring means such as a radar or the like.

(0052) Further, although the shape used for detection of the cut line 70 in the present embodiment was as shown in Figure 5, the invention is not limited by this example, as it is also applicable to a case when the cut line 90 is detected with a shape inclined upward on the left side relative to the horizontal line in a part corresponding to the left side of the illuminated region as shown in the example indicated in Figure 20. Furthermore, it is also possible to use a construction in which the position of the height of the cut line corresponding to the right side of the illuminated region is controlled independently from the position of the height of the cut line corresponding to the left side of the illuminated region.

(0053) Further still, although the light distribution was controlled in the embodiment explained above in the forward direction of the vehicle with a shielding cam, it is also possible to shield the light of the headlamp with a shielding plate, or with a shutter or the like. And although the light distribution was controlled by shielding the light of the headlamps, it is also possible to deflect the axial direction in which the light is emitted from the headlamps.

(0054)

(Effect of the Invention) As was explained above in an embodiment of this invention, when a preceding vehicle is detected based on image signal obtained while the situation in front of the vehicle is filmed, and the position of the boundary between the part that is illuminated by the light of headlamps and the part that is not illuminated by the light of the headlamp is detected, adjacent to the longitudinal direction of the vehicle in a region corresponding to a preceding vehicle in the image, since at least the illumination direction and the range of the illumination of the headlamps can be controlled to lower the position, in order to lower the detected boundary below a specified height and to prevent glare from being inflicted upon a preceding vehicle, the effect obtained in this manner makes it possible to prevent glare from being caused for a preceding vehicle during the travel of the vehicle and under similar conditions.

(Brief Explanation of Figures)

(Figure 1)

An inclined view seen from the front part, indicating the front part of a vehicle used in an embodiment of this invention.

(Figure 2)

An inclined view showing a simplified construction of headlamps compatible with this invention.

(Figure 3)

A cross-sectional view along the line III – III indicated in Figure 2.

(Figure 4)

A flowchart explaining in a simplified manner the construction of a control device.

(Figure 5)

An image diagram used to explain the main control routine in the present embodiment of this invention.

(Figure 6)

A flowchart explaining the man control routine of this embodiment of the present invention.

(Figure 7)

A flowchart explaining in detail recognition processing during the recognition of a preceding vehicle.

(Figure 8)

Figure (A) is an image diagram showing the image filmed with a TV camera during daytime, Figure (B) shows a simplified diagram used to explain integration processing of horizontal image points, Figure (C) is a simplified diagram used to explain the processing during vertical edge detection.

(Figure 9)

A diagram showing the window region during white line recognition.

(Figure 10)

A graph indicating a vehicle recognition region.

(Figure 11)

An image diagram used to explain fluctuations of the image recognition region according to the speed of the vehicle.

(Figure 12)

A graph explaining the relationship between the speed of the vehicle and the correction width applied to an approximately straight line.

(Figure 13)

A graph explaining the relationship between the extent of the right curve in the road and the gain determining the correction width of the approximately straight line on the right side.

(Figure 14)

A graph explaining the relationship between the extent of the right curve in the road and the gain determining the correction width of the approximately straight line on the left side.

(Figure 15)

An image diagram showing the window region applied to a curved road having a differing radius of curvature and the correction width.

(Figure 16)

A graph showing the relationship between the extent of a left curve in the road and the gain determining an approximately straight line on the right side.

(Figure 17)

A graph showing the relationship between the extent of a left curve in the road and the gain determining an approximately straight line on the left side.

(Figure 18)

A graph showing the relationship between the distance between vehicles and the gain determining the angle of rotation of a shielding cam with an actuator.

(Figure 19)

(A) An image graph showing the window region W_s set in the tail part of a preceding vehicle, and (B) an image graph used to explain the course of cut line detection processing.

(Figure 20)

An image graph showing another example of the shape of the cut line.

(Explanation of Symbols)

18 headlamp

[page 8]

20 headlamp

22 TV camera

40 actuator

41 actuator

48 image processing device

50 control device

70 cut line

90 cut line

100 vehicle travel detection device

Figure 1

Figure 2

Figure 3

Figure 5

(1) non-illuminated region

(2) illuminated

(3) region

(4) center

(5) cut line 70

Figure 9

Figure 10

Figure 11

- (6) during a low speed
- (7) during a high speed

[page 9]

Figure 4

- 48 image device
- 58 input port
- 60 output port
- 64 driver

Figure 13

- (8) gain
- (9) (for right curve)
- (10) displacement A

Figure 16

- (11) gain
- (12) (for left curve)
- (13) displacement A

Figure 17

- (15) for left curve
- (16) displacement A

[page 10]

Figure 6

START
300 preceding vehicle recognition processing
302 Is a preceding vehicle present?
304 vehicle distance Len
308 window is set based on the vehicle distance Len and based on the edge of a preceding vehicle
310 binary system is created inside the window
312 differentiation is conducted in the vertical direction, a point at which the differentiated value is exceeded is detected
314 straight line approximation is conducted in the horizontal direction (Hough transform)
316 Straight line approximation OK?
320 the height position X_i of an approximately straight line is calculated
322 Was X_i changed N time from the previous status?
324 approximation impossible counter FC 0
326 Control the direction toward downward direction compared to previous status?
328 realize a specified downward amount of the cut line
330 realize a specified upward amount of the cut line
306 the cut line is controlled according to the distance Len between the vehicles
338 Control the direction toward downward direction compared to previous status?
340 realize a specified upward amount of the cut line
342 realize a specified downward amount of the cut line

[page 11]

Figure 7

(A) preceding vehicle recognition processing
400 white line detection window set
402 edge detection
404 straight line approximation (Hough transform)
405 the curved road extent is calculated
408 the vehicle velocity V is read
410 the window correction width is read

412 preceding vehicle recognition region is set
 416 the vehicle velocity V of the car itself is read
 418 correction value is read
 420 correction gain is read
 422 the window correction width is calculated
 424 preceding vehicle recognition region is set

 426 the vehicle velocity V of the car itself is read
 428 correction value is read
 430 correction gain is read
 432 window correction width is calculated
 434 preceding vehicle recognition region is set

 436 preceding vehicle recognition region
 (horizontal edge point integration)
 438 the position of a preceding vehicle and the distance Len between the vehicles is
 calculated

Figure 12

(17) correction width
 (18) vehicle velocity V

Figure 14

(19) gain
 (20) (for left curve)
 (21) displacement A

Figure 15

(21) displacement A
 (22) large radius of curvature for right curve
 (23) large
 (24) small
 (25) small
 (26) large
 (27) small radius of curvature for right curve

[page 12]

Figure 8

(30) differential value

Figure 19

(28) point above a constant differential value

(29) differential value

Figure 18

(31) actuator

(32) distance L_{en} between vehicles

Figure 20

(33) non-illuminated region

(34) illuminated

(35) region

(36) center

(37) cut line 90

VERIFICATION OF A TRANSLATION

I, the below named translator, hereby declare that:
My name and post office address are as stated below:

Stephen V. Vitek, 1204 False Creek Way, Chesapeake, VA 23322

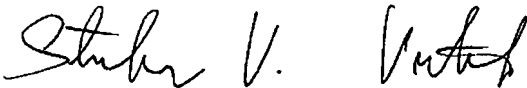
That I am knowledgeable in the English language and in the language in which the below identified international document was written, and that I believe the English translation of the attached document:

Japanese Unexamined Patent Application No. 6-295601 "HEADLIGHT DEVICE FOR VEHICLES", patent applicant Toyota Motor Corporation is a true and complete translation of the above identified document.

I hereby declare that all statements made herein are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the document.

Date: October 13, 2005
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Full name of translator

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